SHORTER ARTICLES AND DISCUSSION

HEREDITY IN A PARTHENOGENETIC INSECT (APHIS)[1]

Statement of Problem

As is well known, Johanssen has found that in self-fertilizing strains of beans selection within the strain—selection in the "pure line"—does not change the mean of successive fraternities. If this conclusion holds generally we should expect it to hold among parthenogenetic species also. Among asexually reproducing animals Jennings (1909) finds that it is true for *Paramecium* and Hanel (1907) for *Hydra*.

Shull (1910) has found that strains of *Hydatina* from New York differ from a strain from Baltimore in the rate of production of males, and Whitney (1912) has found a similar difference in strains. For *Daphnia* (Woltereck, 1910) the persistence of the mode is less easily determined because of a high degree of variability depending on conditions.

Insects seemed to offer a new field for such studies, one in which we might expect external conditions to play a smaller rôle, and because of the well-known parthenogenesis of Aphids and their availability it was determined to test so far as it could be done in a few weeks of a summer, the suitability of plant lice for studies of this sort.

Material and Method

After some experimenting it was decided to use *Aphis rumicis*, an aphid that commonly infests the poppies and nasturtiums about Cold Spring Harbor.

Potted poppies and nasturtiums were kept growing in the laboratory in large aquarium jars (about $\frac{1}{2}$ meter high) covered with cheese cloth. Each plant was carefully inspected to make sure that there were no aphids upon it. Then one gravid female was placed on each plant and its movements and reproduction carefully watched. All young in these summer broods were produced parthenogenetically.

[1] From The Biological Laboratory of the Brooklyn Institute of Arts and Sciences, Cold Spring Harbor, Long Island.

Brood No.	Mother				Offspring								
	Length		Ratio	Wings	1 12			2 13			3 14		
	3d Jt.	4th Jt.	3÷4		3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio
1..	37	24	1.54	Absent	42	30	1.40	43	30	1.43	37	25	1.48
2..	37	23	1.61	Absent	42	29	1.45	45	26	1.73	46	30	1.53
					46	32	1.44	45	29	1.55	43	31	1.39
3..	—	—	—		38	25	1.52	38	26	1.46	37	26	1.42
4..	32	21	1.52	Absent	37	25	1.48	35	25	1.40	37	26	1.42
					39	29.5	1.32	39	29	1.34	41	30	1.37
5..	—	—	—		42	27	1.56	39	27	1.44	41	26	1.58
					41	24	1.71	41	27	1.52	39	29.5	1.53
5*a*.	35	24	1.46	Absent	29	19	1.53	28	18.5	1.51	26	17.5	1.49
					33	23.5	1.40	28.5	18.5	1.54			
5*b*.	33	27	1.22	Present	33.5	22.5	1.49	29	21	1.38	30	19	1.58
5*c*.	35	26.5	1.32	Present	24	15.5	1.55	23.5	15	1.57	28	16.5	1.70
6..	30	20	1.50	Absent	39	24	1.63	37	25	1.48	39	24	1.63
					34.5	24	1.44	37	26	1.42	32	22.5	1.42

Brood No.	Mother				Offspring								
	Length		Ratio	Wings	7 18			8 19			9 20		
	3d Jt.	4th Jt.	3÷4		3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio
1..	37	24	1.54	Absent	41	27.5	1.49	37.5	27	1.39	38	22.5	1.69
2..	37	23	1.61	Absent	43	28.5	1.51	44	32	1.38	44	30.5	1.44
3..	—	—	—		35	24.5	1.43	33	23	1.43	36	26	1.38
4..	32	21	1.52	Absent	38	26	1.46	38	29	1.31	37	26	1.42
					35	25.5	1.37	35	24.5	1.43			
5..	—	—	—		40	27	1.48	39	25	1.56	36	25	1.44
					39	25	1.56						
5*a*.	35	24	1.46	Absent	27	18	1.50	29.3	19.5	1.50	30.5	20.5	1.49
5*b*.	33	27	1.22	Present	36	24	1.50	28	21.5	1.30	30	19	1.58
5*c*.	35	26.5	1.32	Present	26	16.5	1.58	27	17	1.59			
6..	30	20	1.50	Absent	31	22	1.41	36	27	1.33	35.5	26	1.37
					37	25	1.48	35.5	23	1.54	35	23	1.52

Offspring										
4			5			6				
15			16			17				
3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio	Wings of These Offspring	Host Plant
41	24	1.71	41	27	1.52	40	25	1.60	Present	Shirley poppy (grew poorly)
43	30	1.43	44	29	1.52	44	30	1.47	Present	Opium poppy
44.5	33.5	1.33	42	29	1.45				(Winged)	
37	24	1.54	36	25.5	1.41	34	23	1.48	Absent	Shirley poppy
									(Wingless)	
42	27	1.56	36	28	1.29	40	29	1.38	Absent	Nasturtium
40.5	29.5	1.37	36	26.5	1.36	36	26	1.38	(Wingless)	
45.5	28	1.63	40	27	1.48	39	26	1.50	Absent	Opium poppy
36	25	1.44	35	26	1.35	36	22.5	1.60	(Wingless)	
27	19	1.42	32	20	1.60	27.5	20	1.38	Absent	Opium poppy
									(Wingless)	
20	16	1.25	31.5	20	1.58	32	23	1.39	Absent	Opium poppy
34.5	21	1.64	33.5	20	1.68	25	16	1.56	Absent	Opium poppy
35	23	1.52	36	24	1.50	36	25	1.44	Present	Opium poppy
35	22	1.59	37	24	1.54	38	26	1.46	(Winged)	

Offspring								
10			11					
21			22					
3d Jt.	4th Jt.	Ratio	3d Jt.	4th Jt.	Ratio		Wings of These Offspring	Host Plant
42	25	1.68					Present	Shirley poppy (grew poorly)
42.5	31	1.37	42.5	31	1.37		Present	Opium poppy
							Absent	Shirley poppy
38	27	1.41	39	30	1.30		Absent	Nasturtium
41	25	1.64	41	28	1.46		Absent	Opium poppy
29	18.5	1.57	28.5	20	1.43		Absent	Opium poppy
32.3	21.5	1.50	36	22	1.64		Absent	Opium poppy
							Absent	Opium poppy
35.5	22.5	1.58	36	23.5	1.53		Present	Opium poppy
36.5	22.5	1.62	36	24	1.50			

The characteristic whose inheritance it was finally decided to study was the ratio of the third antennal joint to the fourth antennal joint. This ratio offered the advantage of a fairly large range, *i. e.*, from 1.25 to 1.75; and the mode of a fraternity was soon observed to vary from about 1.35 to 1.55.

The measurements were made upon the mother at the same time with the offspring. The offspring were measured when it was obvious that they were mature and soon to breed. The insects were first etherized and the measurements were then made with a micrometer eyepiece, with a magnification such that the third antennal joint averaged about 32 units.

RESULTS

The following table gives the numerical data derived from the measurements made:

The ratios that are derived from measurements of the offspring are grouped into classes, and the frequency of the classes shown graphically in Figs. 1–7.

First, it appears that all aphids fall into two classes, winged and wingless. While the winged mothers had a smaller antennal ratio than the wingless mothers, the antennal ratio shows practically no difference in the winged and wingless *offspring*. Thus 10-winged offspring of a wingless mother give an average antennal index of 1.54, and 5 wingless offspring of the same mother give an average antennal index of 1.48. From a wingless mother with antennal index of 1.46 were derived 13 *wingless* offspring with an average index of 1.49, while from another wingless mother with antennal index of 1.50 were derived 22 *winged* offspring with an antennal index of 1.49. We may compare the antennal indices of the two lots of offspring whether they happen to be winged or not.

The nature of the food plant may be, on the other hand, of importance for the antennal index. Thus of two mothers with practically the same antennal index, one was fed on opium and the other on nasturtium. The progeny of the first finds its mode at 1.50 to 1.59; of the second at 1.30–1.39. It was not possible to determine from comparative studies whether there is uniformly a reduction of the index in the offspring of nasturtium-fed mothers, or whether this result was due to the fact that the nasturtium-fed mothers belonged to a special strain with a low index. In our ignorance it is clearly permissible to

compare only offspring from similarly fed mothers. All data considered below are from offspring of opium-fed mothers.

To decide whether or not we have "pure lines" in *Aphis* it is necessary to breed two generations of offspring; it is better

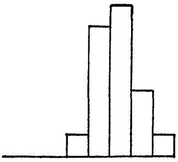


FIG. 1.
5
Opium poppy

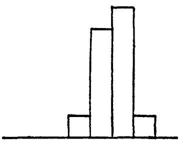


FIG. 2.
5a
Opium
Mother, 1.46.

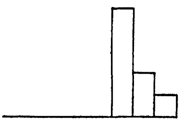


FIG. 3.
5c
Mother, 1.32.
Opium

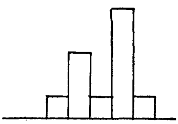
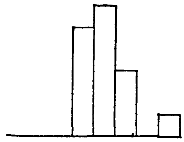


FIG. 4.
5b
Opium



Mother, 1.22.
FIG. 5.
2
Opium
Mother, 1.61

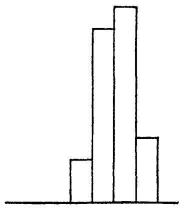


FIG. 6.
6
Opium
Mother, 1.50

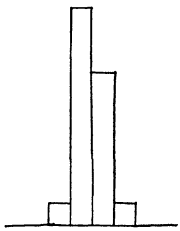


FIG. 7.
4
Nasturtium
Mother, 1.52

to breed more. It is necessary to breed two lines through these generations; it is better to breed three or more. The results so far obtained are inadequate since they continue only one line through two generations of offspring. The data obtained are as follows:

A wingless mother, whose antennal index was not obtained, was fed on opium poppy and produced 18 offspring. The distribution of the antennal ratios of these offspring is as given in Fig. 1. The mode is at 1.50–1.59, the average is 1.53. From this fraternity three individuals were now selected as mothers of the next. We may call them 5*a*, 5*b* and 5*c* (Figs. 4, 5, 6). 5*a* has the highest antennal ratio, 1.46. The mode of the progeny is at 1.55 (1.50–1.59) and the average ratio is 1.49. 5*c* has the next lowest ratio, 1.32. Her progeny also have the mode at 1.50–1.59. The third mother (5*b*) has a ratio of 1.22. The progeny is few in numbers and has two modes of which the major is at 1.50–1.59 like the two others; and the average is 1.47.

The foregoing series of facts may be tabulated as in Table *A*.

TABLE *A*

Family	Maternal Ratio	Offspring	
		Mode	Mean
5a	1.46	1.50–1.59	1.49
5c	1.32	1.50–1.59	1.61
5b	1.22	1.50–1.59	1.47

The table shows clearly that while the range in the maternal ratio is .24, the range in the means is only .14 and that there is no close relation between the order of the maternal ratios and the order of the fraternal means. In all the fraternities the mode stands in the 1.50–1.59 class.

CONCLUSIONS

In so far as this series goes, then, it speaks for the conclusion that, in the parthenogenetic *Aphis rumicis,* the progeny does not inherit the somatic idiosyncrasies of the parent but does inherit from the underlying germ plasm common to all; and hence progeny of somatically quite different sisters tend, on the average, to be alike. The somatic differences in the parthenogenetic line are not inherited.

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THE HIMALAYAN RABBIT CASE, WITH SOME CONSIDERATIONS ON MULTIPLE ALLELOMORPHS

IT has been shown by Castle ('06, '09), Hurst ('06) and Punnett ('12) that the Himalayan pattern in rabbits behaves as a simple recessive to self color, and as a simple dominant to albino. Thus, as Punnett points out, we might suppose self to be the double dominant, Himalayan a recessive in one factor, and albino a double recessive. But, to use Punnett's words: